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Household Firewood Consumption and its Dynamics in Kalisizo Sub-County, Central Uganda

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Abstract

This study examined household firewood consumption and its dynamics in Kalisizo sub-county of Rakai district, central Uganda. Fifty households were conveniently selected and administered with semi-structured questionnaires to determine the preferred tree/shrub species for firewood and the socio-economic dynamic of firewood consumption in the households. Direct measurements were made to quantify the daily amount of firewood consumed by the households. Questionnaire responses were analyzed using Statistical Package for Social Sciences (SPSS), while the volume of firewood consumed per household was computed using the formula, $V = (\pi d^2 l)/4$. Findings indicated a very strong positive correlation ($R^2 = 0.919$) between a household family sizes and the volume of firewood consumed per day. On average, a household with a family size of about seven persons consumed 1.56 m^3 of firewood per year. The most preferred tree and shrub species for firewood were *Sesbania sesban* (85%), *Eucalyptus* (83%), *Calliandra calothyrsus* (73%), *Ricinus communis* (68%), and *Ficus natalensis* (63%). Most of the species were reported to have good combustion characteristics. Firewood collectors covered 8 to 12 km and spent 4 to 6 hours daily to gather firewood, and on average many households collected 4 to 6 headloads of firewood per week. Most people preferred smaller diameter (13–56 mm) pieces of firewood, as they are easy to cut and transport as headloads. All the households interviewed said they occasionally buy firewood especially during rainy seasons and most (92%) of them spend up to UGX 200,000 (US $ 100) per year on firewood. Ninety percent of households made two fires (traditional three-stone fire) per day and 80% prepared two meals per day. There is a need for continued sensitization of household members about fire management in traditional three-stone fire cooking stoves to reduce firewood consumption and waste. Studies have shown that efficiency of a three-stone fire cooking stoves can be quite high if the fire is closely tended and managed. Use of energy saving stoves should also be promoted to save the already scarce firewood. There is also a need for continued encouragement of households to establish their own woodlots in order to reduce the burden of firewood collection on women and children. Lastly, there is a need to quantify opportunity costs foregone by household members involved in firewood collection to give a better picture of the overall dynamic of firewood in rural household economies.

Key words: *Fuelwood, woodfuel, biomass energy, cooking, tree preferences, Uganda*

Introduction

The main use of the world's wood is not as building materials or paper, but as fuel. It is a pattern both ancient and modern, and one that is not likely to change in the next several decades (Matthews, 2000). Today, hundreds of millions of people remain completely reliant upon wood for energy and cannot anticipate any rapid transition to other energy sources. In fact, woodfuels are the world's most important form of non-fossil energy burning (FAO 1999). It occupies enviable place for providing many people, especially the poor and rural households, with a primary source of energy (Leach and Mearns 1988; Eberhard 1990; Hall 1994; Delali *et al.* 2004). Of the 4.4 billion cubic meters (m^3) of wood harvested in 1996, close to half (1.9 billion m^3) are burned for cooking or to provide heat, or are used to make charcoal for later burning (FAO 1999). Leach and Mearns (1988) estimated that 79% of the total traditional energy consumed in developing countries is fuelwood and between 60% and 69% of this is in sub-Saharan Africa. Wood consumed annually for fuel energy in sub-Saharan Africa increased from 1,500 million m^3 to 3,500 million m^3 between 1950 and 1990 (Durning 1991).

In India for instance, an estimated 70% of the energy requirement is met by fuelwood collected from forests and marginal lands (MEF 1996). In parts of the Himalaya per capita annual fuelwood consumption ranged between 500 and 1200 kg (Metz 1990). The natural forests of Siloti and Chanoti in the Himalayas supports 70% and 80% of the two villages respectively, for their fuelwood needs (Tewari *et al.* 2003). In Africa, highly efficient energy resources like kerosene or liquid gas are rare and expensive. Therefore, firewood and charcoal will most likely be major energy resources in the coming decades (Pak 2005). Charcoal has lower transport costs per unit energy and higher energy content per tonne but it is produced inefficiently, so that the scarcity of energy resources is even increased if it is switched from fuelwood to charcoal. The social aspects of the household also influence the efficiency of use of firewood and charcoal. The fireplace is an important location in the social life. In regions where plenty of fuelwood is available, people like to keep the fire a bit longer than is needed only for cooking (Pak 2005). To sit around the fire is as common in Africa as in many other cultures.

In Uganda, firewood is the most significant source of energy, and the majority of the people employ it for domestic use and small-scale industries, e.g. brick and tile making, agro processing and fish processing (Forestry Department 1992; NEMA 1998, Tabuti *et al.* 2003). In urban areas people use charcoal more than firewood. At present because of national energy crisis, demand/consumption for firewood in Uganda is estimated to be growing at a rate of 3% per annum (MEMD 2007). From the historical trend of fuelwood use, it is apparent that there are multifaceted dimensions to utilization rather than from economic perspectives only. The dimensions include livelihood options and strategies. Any disruption in availability and use of wood for fuel energy could render marginalized households vulnerable to livelihood insecurity (Tabuti *et al.* 2003). This is likely to impact on other activities of the household (e.g., division of labour,

cooking and heating, other resource use and allocation). Alternatively, any changes in most household activities could as well affect the use of wood for fuel energy. Subsequently, problems associated with fuelwood consumption cannot be treated in isolation of diversified portfolios of households.

Although fuelwood use has been discussed in literature on world development in recent years (e.g. DFID 2002; World Bank 2002; Tabuti *et al.* 2003, Fisher 2004; Kohlin and Amacher 2006; Arnold *et al.* 2006), such literatures cannot be generalised; diversity is the rule and the only valid information comes from specific data on local conditions (Leach and Mearns 1988; Madubansi and Shackleton 2007). For the case of Kalisizo sub-county of Rakai district, where many families depend on firewood for cooking and other domestic energy requirement, little is known of household woodfuel consumption and its dynamics. This study therefore, examined the household firewood consumption and its dynamics in Kalisizo sub-county of Rakai district, central Uganda. It specifically determined the amount of firewood used by the average household family size, tree species preference for firewood and the socio-economic dynamic of firewood consumption.

Materials and Methods

Study area

The study was conducted in Kalisizo sub-county, Kyotera County in Rakai district. The sub-county is located in the central part of Uganda, about 200 Km from Kampala city. It lies between longitudes 31°E and 32°E, and latitudes 0°S and 1°S (UDIH 2005). The sub-county is situated within a modified equatorial climatic zone with high temperatures. There is a relatively dry season around January and February and another in June, July and in August. However, these dry periods are occasionally mitigated by a few light falls (UDIH 2005). The topography is characterised by a rolling landscape with occasionally rocky hills in some areas. Over 75% of the soils are ferralitic- representing an almost final stage of weathering with little or no mineral reserve left with exception of some heavy clay varieties (REBR 2000). The vegetation is mainly savanna grassland with many thickets of Acacia species (REBR 2000). The major economic activity and livelihood source for the majority of the inhabitants in area is subsistence agriculture.

Study procedure

The sub-county was stratified into seven parishes. Two parishes (Kakoma and Matale) were then randomly selected. In each parish, a convenient sample of 25 households was selected, making a total of 50 households. Convenience sampling is a non-probability sampling technique where subjects are selected because of their convenient accessibility and proximity to the researcher (Hultsch 2002). The technique is fast, inexpensive, easy and the subjects are readily available. Prior to the main survey, the

sub-county and parish chiefs were contacted for permission to carry out research in their area of control.

Questionnaires consisting of a mixture of open- and close-ended questions were administered in face-to-face interviews conducted sometimes in the local language. The major items covered in the questionnaires included the socio-demographic characteristics of the respondents, tree species preferred for firewood and the socio-economic dynamics of firewood consumption. Responses were coded and analysed using Statistical Package for Social Sciences (SPSS). The quantity of firewood consumed by the household was measured over a period of 24 hours. The length (l) and the diameter (d) of individual pieces of the firewood in the bundle that was used on a daily basis were measured using a tape. The volume of each piece of the firewood in the bundle was calculated using the formula: $V = (\pi d^2 l)/4$ (Wood and Wiant 1993) and then averaged.

The bundle was then left in the kitchen of each household with instructions to cook with wood only from the bundle. On the next day the authors returned to each household and the remaining wood were measured to calculate the actual consumption per day, which was subsequently used to determine the volume consumed per year per household. Volume of firewood used per year by the household was regressed against the household family size.

Results

Socio-demographic characteristics of the respondents

The socio-demographic characteristics of the respondents are presented in Table 1. The majority (93%) of the respondents were females because most men shied away from answering questions about firewood. Men believed that women were the ones that could best answer questions about firewood use because they are the one who cook. Fifty-seven percent of the respondents were married, 28% were widowed and 15% were divorced. Majority (67%) of the respondents were more than 40 years old. Large percentages (70%) of the respondents were educated at least up to primary level of education. Ninety-three percent were peasant farmers and 52% had an average family size of seven people.

Quantity of firewood consumed daily by the households in Kalisizo sub-county

The individual pieces of firewood in the headload bundles gathered for daily household domestic energy requirements were small and ranged from 0.33 m to 2.32 m in length, and from 13 mm to 56 mm in diameter. The number of pieces of firewood in an adult headload bundle ranged from 28 to 60 pieces depending on the size of the pieces. The volume of the firewood used per year varied from 0.30 m^3 to 3.01 m^3 depending on the size of the household, with an average volume of 1.56 m^3 for an average household family size of seven persons. There was a very strong positive

correlation (R^2 = 0.919) between the household family size and the volume of firewood consumed per year (Figure 1).

Preferred tree/shrub species for firewood by households in Kalisizo sub-county

When asked about their preferred tree/shrub species for firewood, most respondents provided a list of about 3 to 4 species. The most popular species mentioned was *Sesbania sesban*, desired by 85% of the respondents. Next in importance was *Eucalyptus* spp., with 83%, followed by *Calliandra calothyrsus* (73%), *Ricinus communis* (68%), *Ficus natalensis* (63%) and *Mangifera indica* (58%) (Table 2). Some of the species (e.g. *Mangifera indica* and *Ficus natalensis*) were said to possess good combustion characteristics (e.g. produce quality fire with hot flame, produce less smoke and burn for a longer period) and were multipurpose in use. Mango fruits (*Mangifera indica*) are eaten and sold for cash while the bark of Mutuba tree (*Ficus natalensis*) is used for making bark cloth. Similarly, *Calliandra calothyrsus*, *Leucaena leucocephala*, and *Sesbania sesban* in addition to its use as firewood, were credited for their beneficial roles as fodder crops for livestock and for improving soil fertility. However, some of the species such as 'Musasa' (*Sapium ellipticum*) which burns for a long time with strong embers and hot flames, were said to the very difficult to find.

Socio-economic dynamic of firewood consumption in Kalisizo sub-county

Time spent by household members on collecting firewood varied from one to nine hours but majority (66%) of the household members spent on average 4 to 6 hours for a return journey (Table 3). Most (72%) household members often travel long distances (return journey) of from eight to 12 kilometres to collect firewood. Very few (18%) travelled less than 8 km in search for firewood. Number of headloads of firewood collected per week varied from one to ten, with the majority (64%) of households collecting 4 to 6 headloads per week. All the households interviewed said they occasionally buy firewood especially during rainy seasons. Most (92%) of these households spend up to UGX 200,000 (US $ 100) per year on firewood. The number of fires made and the number of meals prepared per day were virtually identical. Ninety percent of households made two fires per day and 80% prepared two meals per day. Fourteen percent of the households ate three cooked meals and yet only 4% of them made three fires per day (Figure 2). Only 6% of the households made one fire per day and prepared only one meal a day.

Discussion

In Uganda, over 90% of energy used for domestic activities is fuelwood in the form of firewood and charcoal (MWLE 2001). In the current study, the average household of seven persons consumed 1.56 m^3 of firewood per year, and there was a strong positive correlation between the household family size and the volume of

firewood consumed per year. Generally, large household family size is naturally expected to increase firewood consumption because of increased energy demand and increased labour available for firewood collection. Most households collected smaller diameter (13–56 mm) pieces firewood similar to that (15–45 mm diameter) reported by Gandar (1983) for over 80% of the firewood collected in southern Africa. Most firewood collectors' preferred smaller diameter pieces of firewood, as they are easy to cut and light to carry, so a fairly large quantity (headload) can be taken per trip. In Malawi, there is also a report (Abbot and Homewood, 1999) that most women prefers to gather small sized trees for firewood because they are easy and less tiresome to carry as headloads. Similarly, in Ciskei region of southern Africa, Bembridge and Tarlton (1990) reported the preference of smaller pieces of firewood by gatherers as it tends to suit the traditional method of making fires.

Most respondents in the present study were found to be conversant about the tree/shrub species they prefer for firewood in terms of their combustible characteristics. Some preferred species (e.g. *Ficus natalensis*, *Acacia hockii, Ricinus communis* and *Combretum* spp.) were indigenous while others (e.g. *Calliandra calothyrsus* and *Eucalyptus* spp.) were introduced (exotic), although most of them have already become naturalized in the study area. Elsewhere, Yikii *et al.* (2006) also reported preference a mixture of exotic (e.g. *Eucalyptus* spp.) and indigenous species (e.g. *Combretum mole and Combretum collinum*) for firewood by tobacco growing households in northwestern Uganda. FAO (1984), attributed peoples' preference for indigenous species to most exotic tree species for firewood to their slow combustion rates, which results in much heat. This claim was also evident from the present study, where most indigenous species such as *Ficus natalensis* and *Mangifera indica* were credited for having good combustible characteristics such as production of quality fires and ability to burn for longer periods. The high preference of exotic species like *Calliandra calothyrsus* and *Leucaena leucocephala* by the households could perhaps be due to the impact of Vi-Agroforestry Project that operates in Masaka and Rakai districts, promoting the use of multipurpose tree species in local farming systems.

In the African Sahel, it has been reported that household members especially women walk up to 10 km or three hours per day to gather fuelwood (Bukh 1979). In Niger, village women were said to spend about four hours every day gathering wood (Arnold and Jongma 1977). In the present study, most firewood collectors covered 8 to 12 kilometers or spent 4 to 6 hours for two-way trip to gather firewood and on average many households collected 4 to 6 headloads of firewood per week. Aluma (1987) reported that women in rural areas of Uganda walked 4 to 10 km or spent 2 to 6 hours per day in search for firewood. Preference of certain trees/shrubs to others for firewood in itself increases the walking distance and time involved, but most women would rather walk longer distance rather than take any dead wood they come across. However, the long time and distance travel to gather firewood has other implications. First, most women interviewed complained about pains in their back, chest, neck and shoulders after making such long journeys. Secondly, the long time and trips to collect firewood by

women induces neglect of children at home, meals are skipped, the sick ones are not adequately taken care of and the school is not regularly attended as older children either accompany their mothers in search for firewood or are assigned to take care of the young ones and other domestic chores. The need to spend cash to buy firewood at certain times of the year especially the rainy seasons when there is little time to collect firewood because of too much rain and demanding farm work, are also forcing some poorer households to cut down on other vital expenses such as education, clothes and variety in food (balanced diet).

Most households were also observed to be cooking on the traditional three-stone fire stoves, in which more firewood were burned than necessarily required in the cooking process. The fires was maintained by pushing at least three pieces firewood into the hot ashes and, according to the heat requirements, are pushed further in (more heat) or pulled out partly (less heat). However, much of the heat generated is often wasted because the cooking is usually done in open. The number of fires made and the number of meals prepared per day were generally identical except in a few cases where households ate more cooked meals and than the fires made per day. Where more meals than fires were prepared, it was assumed that the family had some cold meals.

The scarcity of firewood in study area was eminent from the average distance travelled by collectors in search of firewood. Therefore, there is a need to sensitize the rural household members about fire management in their predominantly used traditional three-stone cooking stoves as one way of reducing firewood consumption and waste. Studies have shown that the efficiency of a three-stone cooking stoves can be quite high if the fire is closely tended and managed (Dewees 1989). Community based organizations and local governments at parish level could take a lead in this endeavour. Use of energy saving stoves should also be encouraged in order to save the already scarce firewood. There is also a need for continued encouragement of individual households to establish their own woodlots in order to reduce the burden of firewood collection on women and children. Lastly, there is a need to quantify opportunity costs (e.g. farm work by women and school going time by children) foregone by household members involved in firewood collection. Quantification of these opportunities costs could perhaps give a better and realistic picture of the overall dynamic and contribution of firewood in rural household economies.

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Table 1. Socio-demographic characteristics of the respondents in Kalisizo sub-county, Rakai district, Uganda.

Variable	% response (N = 50)
Sex	
Female	93
Male	07
Age (years)	
< 20	13
20-40	20
> 40	67
Marital status	
Married	57
Widow/widower	28
Divorced	15
Education level	
No formal education	08
Primary	70
Secondary	22
Occupation	
Peasantry farming	93
Others (teaching, causal labouring)	07
*Family size**	
1 – 4	30
5 – 8	52
> 8	18

*Average household family size = 7 persons.

Table 2. Tree species preferred for firewood in Kalisizo sub-county, Rakai district, Uganda.

Tree/shrub species	Local name	% response	Origin	Desirable attributes reported	Descriptive remarks
Sesbania sesban (L.) Merr.	Muzimbandeya	85	Indigenous	A, B, C	Shrubby multi-branched tree that grows about 5 to 8 m tall.
Eucalyptus spp.	Kalitunsi	83	Introduced/ naturalised	D, E, I, J	Species grow to variables height (10-60 m). Highly coppicing when cut. Drains water from the soil.
Calliandra calothyrsus Meissn.	Calliandra	73	Introduced/ naturalised	A, C, D, E,	Small and thornless leguminous tree growing up to about 12 m high.
Ricinus communis L.	Nsogasoga	68	Indigenous	A, F	Shrub-like multi-branched herb growing to about 5 metres high. Seeds very poisonous.
Ficus natalensis Hochst.	Mutuba	63	Indigenous	C, G, D, H, I, J	Shrubby tree/strangler growing up to about 20 m high or more. Bark used for making bark cloth.
Mangifera indica.	Muyembe	58	Introduced/ naturalised	C, G, D, H, I, J	Fruit tree that grow to about 35-40 m tall, with often a wide crown diameter of about of 20 m.
Leucaena leucocephala (Lam.) De Wit.	Leucaena	55	Introduced	A, C, D, E	Shrub/tree growing up to about 15-18 m tall, forked when shrubby and branching strongly after coppicing.
Markhamia lutea (Benth.) K.Schum.	Nsambya, lusambya	50	Indigenous	G, H	Upright evergreen tree growing 10-15 m high, with a narrow, irregular crown.
Combretum spp.	Mukoola, Ndagi	48	Indigenous	D, G, H, J	Shrub/small to medium size trees growing to variables heights (3-20 m high).
Bridelia micrantha (Hochst.) Baill.	Katazamiti	40	Indigenous	C, G, H, I	Tree growing up to about 20 m tall with a dense rounded crown.

Grevillea robusta A. Cunn. ex R. Br.	Grevillea	35	Introduced	C, G	Medium-sized to large tree growing to about 12-25 m high with dense conical crown.
Polyscias fulva (Hiern) Harms.	Setala	23	Indigenous	C, D, G	Tree growing up to 25-30 m high, with a regular branching pattern and a clear, straight bole with branches developing high up.
Acacia hockii De Wild.	Kasana	15	Indigenous	D, I	Small to medium-sized tree, growing to about 15-17 m tall.
Acacia mellifera (Vahl) Benth.	Matovu	13	Indigenous	D, I	Low branched tree/shrub with a more or less spherical crown growing often as a dense thicket of 2-5 m high.
Senna spectabilis (DC.) H. S. Irwin and R. C. Barneby.	Cassia	10	Introduced/ naturalised	D, I	Small rounded tree growing 7-15 m tall with a spreading crown.
Sapium ellipticum (Hochst.) Pax.	Musasa	08	Indigenous	D, G, I	Medium-sized tree up to 12-15 m in height, occasionally reaching 25 m.

Desirable attributes of firewood tree species reported by respondents: A=easy to ignite, B=easy to gather/harvest, C= multipurpose, D=quality fire, E=coppices quickly, F=easy to find, G= Burns for a long time, H=produces strong embers, I= has a hot flame, J=produces less smoke.

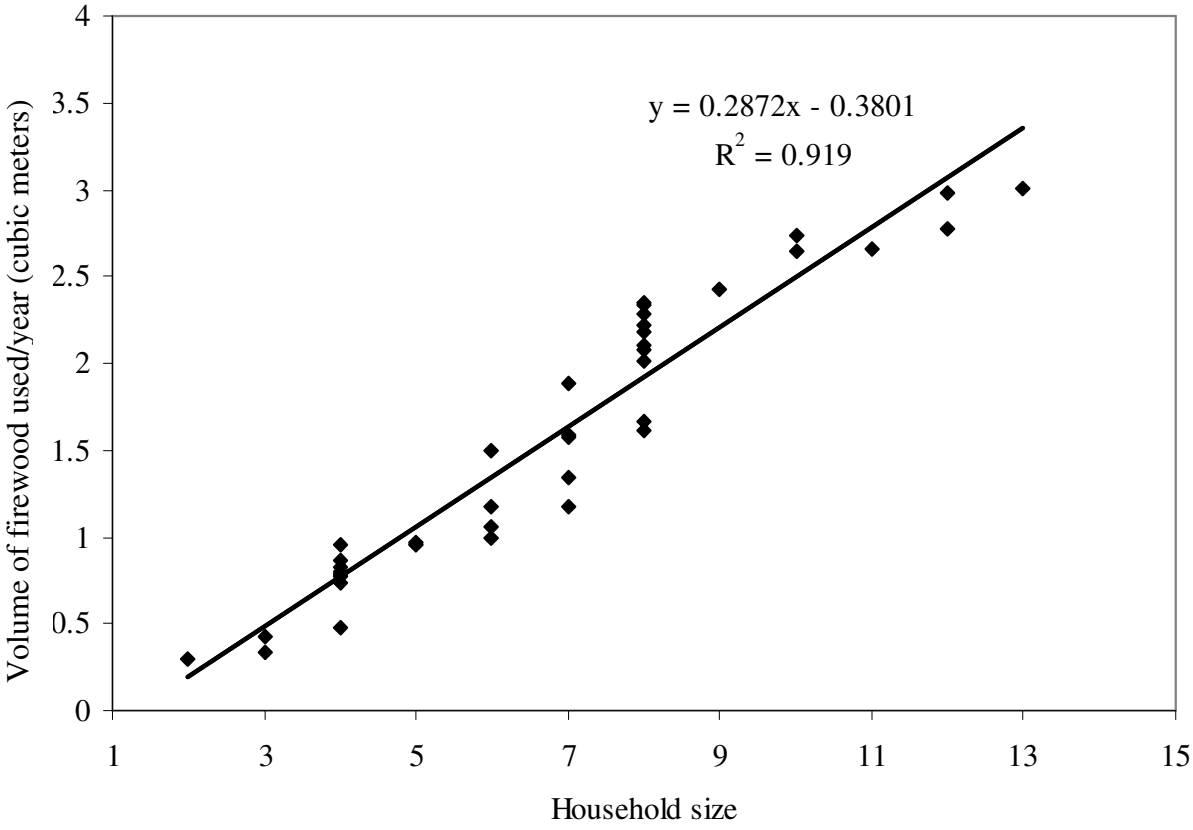

Figure 1. Volume of firewood used per year by the household in Kalisizo sub-county, Rakai district (Averaged volume/year = 1.56 m^3, averaged household size = 7 persons).

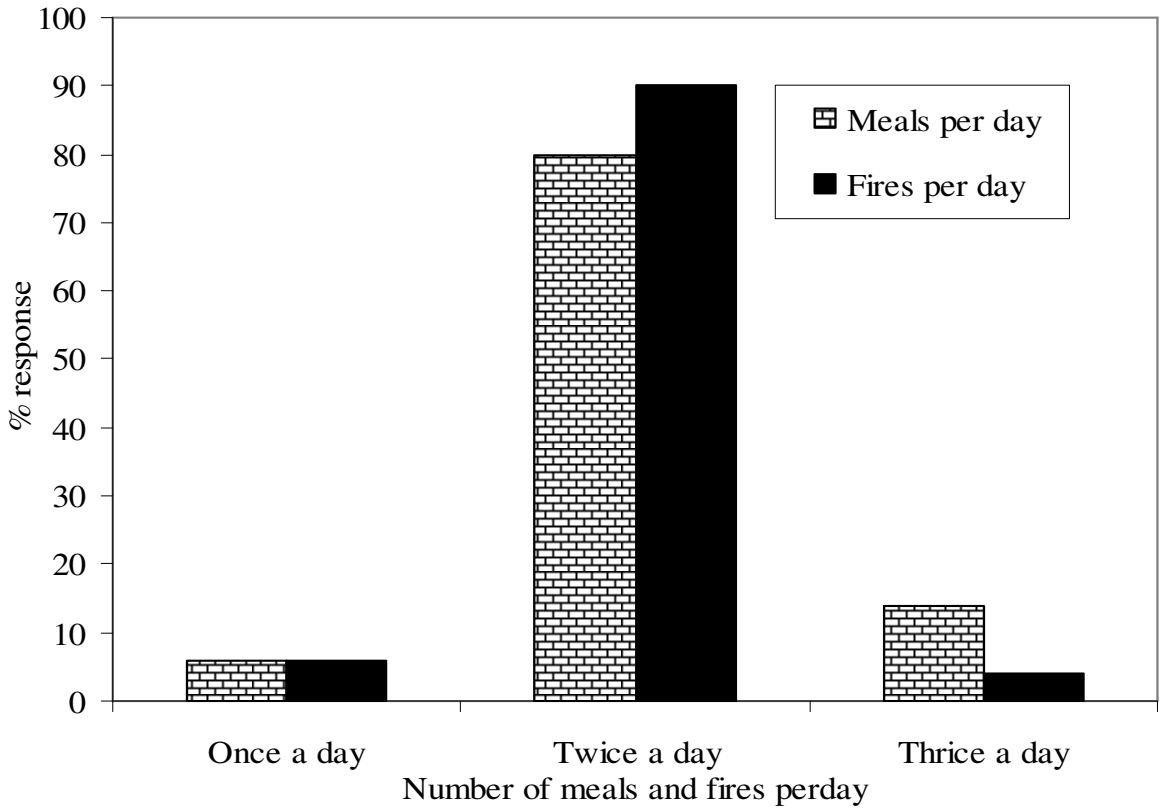

Figure 2. Number of fires made and meals prepared per day by the households in Kalisizo sub-county, Rakai district.

Table 3. Socio-economic dynamic of firewood consumption in Kalisizo sub-county, Rakai district, Uganda.

Variable	% response
Time (hours) spent on collecting firewood for two-way trip	
1–3	22
4–6	66
7–9	12
Distance (Km) covered for two-way trip	
3–7	18
8–12	72
> 12	10
Frequency of firewood collection (number of headloads per week)	
1–3	20
4–6	64
7–10	16
*Amount of money (Uganda shillings) spent per year on firewood**	
100,000–200,000	92
201,000–300,000	6
>300,000	2

*1 Uganda shillings (UGX) = US $ 0. 0005